

## WHAT IS CLAIMED IS:

1. A semiconductor laser device comprising:  
a reflective film constituted of multilayer dielectric  
films, being provided on at least one side of optical exit  
faces of a laser chip;  
wherein the reflective film includes, in sequence from a  
side in contact with the laser chip, a first dielectric film  
of a refractive index  $n_1$ , a second dielectric film of a  
refractive index  $n_2$ , a third dielectric film of a refractive  
index  $n_3$  and a fourth dielectric film of a refractive index  
 $n_4$ , and each of refractive indices satisfies a relation:  $n_2 =$   
 $n_4 < n_1 < n_3$ .
2. A semiconductor laser device comprising:  
a reflective film constituted of multilayer dielectric  
films, being provided on at least one side of optical exit  
faces of a laser chip;  
wherein the reflective film includes, in sequence from a  
side in contact with the laser chip, a first dielectric film  
of a refractive index  $n_1$ , a second dielectric film of a  
refractive index  $n_2$ , a third dielectric film of a refractive  
index  $n_3$  and a fourth dielectric film of a refractive index  
 $n_4$ , and each of refractive indices satisfies a relation:  $n_2 =$   
 $n_4 < n_3 < n_1$ .
3. The semiconductor laser device according to Claim  
1, wherein each thickness of the first to fourth dielectric

films is set up, in terms of optical length, within  $\pm 30\%$  of range of a thickness of an integral multiple of  $1/4$  oscillation wavelength.

4. The semiconductor laser device according to Claim 5 2, wherein each thickness of the first to fourth dielectric films is set up, in terms of optical length, within  $\pm 30\%$  of range of a thickness of an integral multiple of  $1/4$  oscillation wavelength.

5. A semiconductor laser device which emits light of 10 oscillation wavelength  $\lambda$ , comprising:

a reflective film constituted of multilayer dielectric films, being provided on at least one side of optical exit faces of a laser chip;

wherein the reflective film having a reflectance of 15 3% to 15% includes, in sequence from a side in contact with the laser chip, a first dielectric film of a refractive index  $n_1$  and a thickness  $d_1$ , a second dielectric film of a refractive index  $n_2$  and a thickness  $d_2$ , a third dielectric film of a refractive index  $n_3$  and a thickness  $d_3$ , and a fourth 20 dielectric film of a refractive index  $n_4$  and a thickness  $d_4$ , and

the refractive index  $n_1$  satisfies  $1.6 < n_1 \leq 1.9$ , the refractive index  $n_2$  satisfies  $1.3 \leq n_2 \leq 1.6$ , the refractive index  $n_3$  satisfies  $1.9 < n_3 \leq 2.3$ , and the refractive index 25  $n_4$  satisfies  $1.3 \leq n_4 \leq 1.6$ , and

the thickness  $d_1$  is substantially equal to  $(2*h + 1)\lambda/(4*n_1)$ , the thickness  $d_2$  is substantially equal to  $(2*i + 1)\lambda/(4*n_2)$ , the thickness  $d_3$  is substantially equal to  $(2*j + 1)\lambda/(4*n_3)$ , and the thickness  $d_4$  is substantially equal to  
5       $(2*k + 1)\lambda/(4*n_4)$ , wherein each of  $h$ ,  $i$ ,  $j$  and  $k$  is zero or more integer.

6. A semiconductor laser device which emits light of oscillation wavelength  $\lambda$ , comprising:

10      a reflective film constituted of multilayer dielectric films, being provided on at least one side of optical exit faces of a laser chip;

15      wherein the reflective film having a reflectance of 3% to 15% includes, in sequence from a side in contact with the laser chip, a first dielectric film of a refractive index  $n_1$  and a thickness  $d_1$ , a second dielectric film of a refractive index  $n_2$  and a thickness  $d_2$ , a third dielectric film of a refractive index  $n_3$  and a thickness  $d_3$ , and a fourth dielectric film of a refractive index  $n_4$  and a thickness  $d_4$ , and

20      the refractive index  $n_1$  satisfies  $1.9 < n_1 \leq 2.3$ , the refractive index  $n_2$  satisfies  $1.3 \leq n_2 \leq 1.6$ , the refractive index  $n_3$  satisfies  $1.6 < n_3 \leq 1.9$ , and the refractive index  $n_4$  satisfies  $1.3 \leq n_4 \leq 1.6$ , and

25      the thickness  $d_1$  is substantially equal to  $(2*h + 1)\lambda/(4*n_1)$ , the thickness  $d_2$  is substantially equal to  $(2*i +$

1)  $\lambda/(4*n_2)$ , the thickness  $d_3$  is substantially equal to  $(2*j + 1)\lambda/(4*n_3)$ , and the thickness  $d_4$  is substantially equal to  $(2*k + 1)\lambda/(4*n_4)$ , wherein each of  $h$ ,  $i$ ,  $j$  and  $k$  is zero or more integer.

5        7. The semiconductor laser device according to Claim 1, wherein the first dielectric film is formed of either of  $Al_2O_3$ ,  $CeF_3$ ,  $NdF_3$ ,  $MgO$  and  $Y_2O_3$ , the second and fourth dielectric films are formed of either of  $SiO_2$ ,  $MgF_2$ ,  $BaF_2$  and  $CaF_2$ , and the third dielectric film is formed of either of  $Ta_2O_5$ ,  $SiO$ ,  $ZrO_2$ ,  $ZnO$ ,  $TiO$ ,  $TiO_2$ ,  $ZnS$ ,  $Nb_2O_5$ ,  $HfO_2$  and  $AlN$ .

10      8. The semiconductor laser device according to Claim 5, wherein the first dielectric film is formed of either of  $Al_2O_3$ ,  $CeF_3$ ,  $NdF_3$ ,  $MgO$  and  $Y_2O_3$ , the second and fourth dielectric films are formed of either of  $SiO_2$ ,  $MgF_2$ ,  $BaF_2$  and  $CaF_2$ , and the third dielectric film is formed of either of  $Ta_2O_5$ ,  $SiO$ ,  $ZrO_2$ ,  $ZnO$ ,  $TiO$ ,  $TiO_2$ ,  $ZnS$ ,  $Nb_2O_5$ ,  $HfO_2$  and  $AlN$ .

15      9. The semiconductor laser device according to Claim 2, wherein the first dielectric film is formed of either of  $Ta_2O_5$ ,  $SiO$ ,  $ZrO_2$ ,  $ZnO$ ,  $TiO$ ,  $TiO_2$ ,  $ZnS$ ,  $Nb_2O_5$ ,  $HfO_2$  and  $AlN$ , the second and fourth dielectric films are formed of either of  $SiO_2$ ,  $MgF_2$ ,  $BaF_2$  and  $CaF_2$ , and the third dielectric film is formed of either of  $Al_2O_3$ ,  $CeF_3$ ,  $NdF_3$ ,  $MgO$  and  $Y_2O_3$ .

20      10. The semiconductor laser device according to Claim 6, wherein the first dielectric film is formed of either of  $Ta_2O_5$ ,  $SiO$ ,  $ZrO_2$ ,  $ZnO$ ,  $TiO$ ,  $TiO_2$ ,  $ZnS$ ,  $Nb_2O_5$ ,  $HfO_2$  and  $AlN$ , the

second and fourth dielectric films are formed of either of  $\text{SiO}_2$ ,  $\text{MgF}_2$ ,  $\text{BaF}_2$  and  $\text{CaF}_2$ , and the third dielectric film is formed of either of  $\text{Al}_2\text{O}_3$ ,  $\text{CeF}_3$ ,  $\text{NdF}_3$ ,  $\text{MgO}$  and  $\text{Y}_2\text{O}_3$ .

11. The semiconductor laser device according to Claim  
5 1, wherein a multilayer dielectric film in combination with a  
fifth dielectric film and a sixth dielectric film is  
additionally formed in a region other than a light emitting  
point on the optical exit faces of the laser chip, and a  
reflectance of the region other than the light emitting point  
10 is smaller than a reflectance of the region of the light  
emitting point.

12. The semiconductor laser device according to Claim  
2, wherein a multilayer dielectric film in combination with a  
fifth dielectric film and a sixth dielectric film is  
15 additionally formed in a region other than a light emitting  
point on the optical exit faces of the laser chip, and a  
reflectance of the region other than the light emitting point  
is smaller than a reflectance of the region of the light  
emitting point.

20 13. The semiconductor laser device according to Claim  
11, wherein each thickness of the fifth and sixth dielectric  
films is set up, in terms of optical length, within  $\pm 30\%$  of  
range of a thickness of an integral multiple of  $1/4$   
oscillation wavelength.

25 14. The semiconductor laser device according to Claim

12, wherein each thickness of the fifth and sixth dielectric films is set up, in terms of optical length, within  $\pm 30\%$  of range of a thickness of an integral multiple of  $1/4$  oscillation wavelength.

5        15. The semiconductor laser device according to Claim 13, wherein the fifth dielectric film is formed of either of  $\text{Al}_2\text{O}_3$ ,  $\text{CeF}_3$ ,  $\text{NdF}_3$ ,  $\text{MgO}$  and  $\text{Y}_2\text{O}_3$ , and the sixth dielectric film is formed of either of  $\text{SiO}_2$ ,  $\text{MgF}_2$ ,  $\text{BaF}_2$  and  $\text{CaF}_2$ .

10      16. The semiconductor laser device according to Claim 14, wherein the fifth dielectric film is formed of either of  $\text{Al}_2\text{O}_3$ ,  $\text{CeF}_3$ ,  $\text{NdF}_3$ ,  $\text{MgO}$  and  $\text{Y}_2\text{O}_3$ , and the sixth dielectric film is formed of either of  $\text{SiO}_2$ ,  $\text{MgF}_2$ ,  $\text{BaF}_2$  and  $\text{CaF}_2$ .

15      17. The semiconductor laser device according to Claim 1, wherein the laser chip has a plurality of light emitting points which emit two or more different oscillation wavelengths.

20      18. The semiconductor laser device according to Claim 2, wherein the laser chip has a plurality of light emitting points which emit two or more different oscillation wavelengths.

19. The semiconductor laser device according to Claim 1, wherein two or more of the semiconductor laser devices are arranged in a single package, and each of laser chip emits different oscillation wavelength from each other, and each of 25 multilayer dielectric film on the optical exit face of each

laser chip is formed of the same material with the same thickness.

20. The semiconductor laser device according to Claim 2, wherein two or more of the semiconductor laser devices are arranged in a single package, and each of laser chip emits different oscillation wavelength from each other, and each of multilayer dielectric film on the optical exit face of each laser chip is formed of the same material with the same thickness.